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Visual Motor Integration in Children with and without Reading Disabilities in Oman

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Abstract

This study investigated the differences in visual-motor integration (VMI) between children with and without reading disabilities (RDs) in the Sultanate of Oman by employing the Full Range Test of Visual Motor Integration (FRTVMI, Hammill, Pearson, Voress, & Reynolds, 2006). A total of 364 pupils from public elementary schools in Muscat, the capital of Oman, participated in the study; 171 pupils were already diagnosed as having RDs whereas 175 were normally achieving (NA) pupils. After examining internal consistency estimates of the FRTVMI on the sample a two-way analysis of variance (ANOVA) was conducted to examine the differences in VMI between the two pupil groups. Additionally, the effects of gender as well as the interaction between gender and pupil condition (RDs vs. ND) were examined. The results indicated that NA children scored higher on the FRTVMI than did the children with RDs. There were no significant differences in VMI between males and females in the two children groups. The interaction between gender and group condition (RDs vs. NA), however, showed that NA female pupils displayed the highest levels of VMI whereas female pupils with RDs displayed the lowest level of VMI. The results support the theoretical propositions that learning disabilities (LDs) in general and RDs in particular are strongly related to impairment in VMI and therefore assessment of such skill is important in diagnosing children who are suspected of being at risk for RDs in school settings.

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Keywords: Visual motor integration; pupils with reading disabilities

1. Introduction

In Oman, where there is a lack of occupational therapists, it is common for educational psychologists and/ or special educators to assess and evaluate visual motor integration (VMI) as part of their assessment of individuals

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with learning disabilities (LDs). The availability of instruments and those who are trained to administer them is, however, problematic. VMI is generally defined as the degree to which visual perception (information) and limb movement (finger–hand movements) are well coordinated and integrated together (Beery & Beery, 2006; Gabbard, Goncalves, & Santos, 2001). VMI dysfunction is the inability to use vision to perform motor-based tasks; hence, functional VMI enables a child to coordinate visual stimuli with the corresponding motor action in a timely and skillful manner (Schneck, 2010).

VMI and visual perceptual problems are common in children with reading disabilities which result from atypical brain functioning as well as atypical information processing (DSM-IV-TR, 2000; Beaton, 2004; Chinner, Brown, & Stagnitti, 2011). Indicators of VMI function may include legible handwriting, skillfully constructing objects with building blocks, and ability to complete most visual/motor activities at an adequate speed (Schneck, 2010; Cronin & Mandich, 2005). Indicators of VMI dysfunction may be seen in children whose handwriting is messy and who are unable to form letters legibly or copy letters; who have difficulty constructing objects with building blocks, doing puzzles, using fasteners in dressing, tying shoe laces; and who have decreased or slow speed at completing visual/motor tasks (Schneck, 2010). These characteristics are notable among children with RDs (Beaton, 2004). VMI and visual perceptual problems are often linked to difficulties in a number of school related tasks including handwriting; spelling; mathematics; self-care; participation in play, recreation, and/or leisure activities (Brown, Rodger, & Davis, 2003).

Amongst the VMI assessments that are currently available is the Full Range Test of Visual Motor Integration (FRTVMI; Hammill, Pearson, Voress, & Reynolds, 2006) which is a standardized, norm-referenced assessment. Standardized assessments are used in educational settings as they provide precise measurements of an individual's performance area compared to his age group members, describe the performance as a standard score that can quantify the educational psychologist's or special educator's assessment judgments, and provide evidence which can inform the intervention phase (Payne, 2002).

Two psychometric properties are important for accurate and meaningful indicators in standardized tests, namely reliability and validity. Reliability is the extent to which a measurement is constant and free from error and can be conceptualized as dependability, repeatability, or reproducibility (Portney &Watkins, 2009). In terms of assessment, validity refers to the extent to which a test's items are representative of the actual skills, abilities, or traits being evaluated and whether the test can allow accurate conclusions concerning achievement. In other words, validity is the extent to which a test measures what it claims to measure.

To the authors' knowledge the FRVMI has not been reported in any study on an Arabic sample in general and on an Arabic sample of children with RDs in particular. Thus evaluating its use on such samples is timely and needed.

2. The Current Study

The Sultanate of Oman is moving towards transferring public schools to be inclusive schools which provide special education services to pupils with special educational needs (SEN). Statistics of the Department of Special Education at the Ministry of Education (MoE) in Oman show that the number of pupils with LDs who receive special education services in inclusive schools has increased significantly in the last decade. The number of pupils with RDs represents 80% of the total number of pupils with LDs. In addition, schools have become incapable of providing special education services to more pupils with LDs in general and to pupils with RDs in particular due to lack of both human and learning resources. Since 2007 the MoE began to include children with LDs. By an Educational Mandate in 2007 which was issued in accordance with the Omani Children with Disabilities Care and Rehabilitation Act in 1996 that was reauthorized in 2008, children with LDs became eligible for receiving additional help through tasks that are given by the special education teachers who hold a specialized one year Higher Diploma in LDs, a program which is tailored by Sultan Qaboos University to fulfill the training needs of the Ministry of Education professionals in the Sultanate of Oman (Emam, 2012).

In school settings, educational psychologists quite often use psychological instruments to examine their academic as well as developmental abilities including reading, spelling, mathematics, phonological processing, phonological awareness, memory, attention, and VMI (Hecht, Torgesen, Wagner, & Rashotte, 2001; Kirby, Parrila, & Pfeiffer, 2003). In Oman is not quite common to rely on such comprehensive assessment and instead an identification of a discrepancy between IQ and achievement is sufficient to give the LD label to a pupil. Without a thorough psychological assessment, it is likely that pupils, teachers, and parents will not truly understand the cause of the child's academic difficulties or know which accommodations are best suited to the needs of the pupil. As a result, it is unlikely that identified pupils or their parents will advocate for appropriate accommodations and supports (Harrison, Nichols, & Larochette, 2008). Furthermore, insufficient assessment leads to incomplete documentation, which affects the provision of necessary services.

Because academic difficulties can occur for many reasons, one particularly important area to evaluate when testing for LD in general and RDs in particular is information processing, as it relates to specific cognitive functions (Harrison, 2005; Silver et al., 2008). Research has indicated that LDs are strongly related to impairment in specific cognitive processes (Swanson & Jerman, 2006; Geary, Hoard, Byrd-Craven, Nugent, & Numtee, 2007). Therefore, assessment of these processes allows clinicians as well as educators to determine which specific areas of cognitive impairment are affecting the academic achievement of a given pupil. Once particular cognitive deficits are identified, appropriate accommodations can be recommended that are most likely to target the specific area of disability. Furthermore, understanding the cognitive underpinnings of a given student's LD can also help clarify the scope of impairment, prognosis for future development in given areas, and the degree to which academic strategies are likely to be effective. Unfortunately, it appears that most assessments fail to evaluate such skills. Indeed, in a recent study, Harrison et al., (2008) found that fewer than 20% of university students requesting accommodations for LD at Canadian institutions had been given tests of information processing in their most recent assessment. Similarly, a survey administered to American clinicians found that roughly 30% of respondents still believed that a discrepancy between an individual's IQ and achievement scores was sufficient for the diagnosis of LD (Gordon, Lewandowski, Murphy, & Dempsey, 2002). This indicates that many professionals were unaware that the administration of information processing tests is necessary to fully understand the nature of a given pupil's LD and make appropriate recommendations. Similarly in the Sultanate of Oman there is an absence of a comprehensive assessment of children with LDs in school settings. In the absence of comprehensive assessment of all cognitive and other related functions, it seems likely that misidentification of the actual cause for academic struggles will occur frequently, and that accommodation recommendations may not target the appropriate impairments.

Given such lack of comprehensive assessment of cognitive processes in the Sultanate of Oman, the overall purpose of this study was to examine VMI in children with and without RDs by employing an instrument which was recently developed for this purpose and used elsewhere. Additionally the study aimed to examine the reliability of the FRTVMI in a cross-cultural context (that being Arab context). The study seeks to answer the following questions:

- Do children with RDs differ from NA children in their VMI?
- Does gender have an effect on the children's performance on the FRTVMI?
- Does the interaction between gender and pupils condition (RDs vs. NA) have an effect on the children's performance on the FRTVMI?

3. Method

3.1. Participants

Participants of the study included 171 pupils with RDs (63 female, 108 male, mean age 8.61 ± 0.81years) and 175 randomly selected normally achieving (NA) pupils (72 female, 172 male, mean age = 8.62 ± 0.89 years) were recruited from elementary public schools at Muscat, the capital of Oman. Although socio-economic data are not typically collected in the Omani educational system, the schools appeared to be in middle class regions and

serve middle class families. The schools offered regular education while providing specialized instruction to pupils with RDs only for some time during the school day. Pupils with RDs in the current study were typically enrolled in one pull-out learning support class, and were eligible for additional drop-in support as needed. They received extra support in resource rooms: they spent an average of 8 hours per week in a resource room, where they received extra support in reading and writing by a special needs educator who specializes in LDs in general and RDs in particular. The selected participants were predominantly Arabic-speaking indigenous Omani pupils. Pupils identified as having RDs by the school Local Education Authorities (LEAs) were assessed by trained educational psychologists or special educators and met criteria set by LEAs based on (a) a record of poor academic achievement in reading or writing, (b) an IQ-achievement discrepancy of 1.5 standard deviations or greater, (c) absence of any sensory problems or impairments, and (d) a record of continued poor achievement in spite of intensive academic support. In addition, pupils with RDs were identified based on their inadequate performance on the Omani curriculum-based tests which assessed their reading and writing skills.

3.2. Instrument & Procedures

The FRTVMI is a standardized, norm-referenced test of VMI that uses a copying format (Hammill et al., 2006). The FRTVMI is a recent revision of the Test of Visual Motor Integration (TVMI) and was designed to assess the ability to reproduce visual stimuli using motor responses for children, adolescents, adults and older adults (Hammill et al., 1996). Full Range was added to the title to indicate that the FRTVMI's norms were extended to include adults and older adults in order to differentiate potential neuropsychological and psychological conditions in older people. The age range of the FRTVMI's child norms is 5 years to 10 years 11 months, while that of the adult norms is 11 years to 74 years 11 months. The FRTVMI is made up of 18 geometric shapes and figures administered to respondents in a seven-page booklet, with six figures in boxes on each page. The geometric designs are to be copied by the respondent directly beneath the figure provided in the test booklet. Several factors have an impact on the length of the test, including the test taker's age, ability to draw the figures accurately, and speed of completing the copying task. Administration of the RTVMI usually takes 10-30 minutes and scoring takes another 15 minutes.Prior to commencement of the study, ethical approval was sought from, and granted by, Sultan Qaboos University Human Ethics Advisory Board. Ethical guidelines were strictly adhered to throughout this study. Information about the study was sent LEAs which in turn contacted parents to take permission for the participation of their children. In addition to parents' permission, pupils listened to a brief talk on the reasons for administering the test and all pupils who were approached agreed to participate in the study. The test booklet included demographic information.

3.3. Data analysis

All data obtained from the FRTVMI, and the demographic information was coded and entered using the Statistical Package for Social Sciences (SPSS, Version 16.0). Descriptive statistics were utilized to analyze data related to demographic information. Cronbach's alpha coefficient was used to examine the internal consistency of the FTTVMI. A two way analysis of variance (ANOVA) was used to determine whether there are differences between pupils with RDs and NA pupils in VMI. Additionally the effect of gender as well as the interaction between gender and pupil condition (RDs vs. NA) were examined.

3.4. Reliability and validity of the FRTVMI

The psychometric properties of the FRTVMI were reported in the test manual. Cronbach's alpha of 0.90, and test-retest reliability of .85 were reported for the older adults sample, whereas limited psychometric properties were reported for children since the test was published. Validity was claimed relying on content validity, concurrent validity with previously reported valid tests of VMI, and criterion prediction validity with

test of associated concepts such as tests of visual perception. The FRVMI has recently been the focus of a number of studies which tested it psychometric properties including reliability and validity on both children and adults, comparing it to other VMI instruments (Chinner eta al., 2011, Brown, Chinner, & Stagnitti, 2011, Brown, Chinner, & Stagnitti, 2010). Chinner et al. (2011) found that the FRVMI exhibited a lower level of reliability compared to the Developmental Test of Visual Motor Integration (DTVMI; Beery & Beery, 2006), with a Cronbach's alpha of .72 and a test re-test reliability coefficient of .49 (p=.05) . However the authors recommended using the FRVMI with children and young people as it exhibited reasonable level of reliability particularly as they significantly correlated and exhibited large levels of convergent validity with each other in another study (Brown et al., 2011). Given that the FRTVMI's norms have been expanded to include adults and older people and the fact that the FRTVMI was standardised in the United States, its validity and reliability in cross-cultural contexts would be informative. In our study we relied on internal consistency to establish reliability. Cronbach's alpha for pupils with RDs and NA pupils good ($\alpha = 0.81$ and 0.84 respectively).

4. Results

To examine whether there are differences in VMI between children with RDs and ND pupils and whether gender or the interaction between gender and pupil condition have effects on children's VMI we conducted a two-way. Tables 1 and 2 show the results of the two-way ANOVA.

Table 1 Descriptive Statistics

Condition	Gender	N	Mean	SD
NA	Male	103	31.94	7.37
	Female	72	33.58	5.61
	Total	175	32.62	6.73
RDs	Male	108	28.97	6.31
	Female	63	27.73	5.86
	Total	171	28.51	6.16
Total	Male	211	30.42	6.99
	Female	135	30.85	6.41
	Total	346	30.59	6.77

Note: NA= Normally Achieving pupils; RDs= Reading Disabilities; N= Number of Participants

Table 2 A two-way ANOVA

Source	Sum of Square	df	Mean Square	F	Sig.	Partial Eta Squared
Condition	1597.377	1	1597.377	38.558	.000	.101
Gender	3.276	1	3.276	.079	.779	.000
Gender*Condition	170.643	1	170.643	4.119	.043	.012
Error	14168.480	342	41.428			

According to table 1 NA pupils performed higher on the FRTVMI (M= 32.62) than did the pupils with RDs (M= 28.51). As table 2 shows, the two-way ANOVA with VMI (low and high) as between-subjects factors revealed a main effects of pupil condition (RDs vs. NA), $F(1, 342) = 38.558$, $p = .001$, $\eta p^2 = .101$, and the interaction between gender and pupil condition, $F(1, 342) = 4.119$, $p = .043$, $\eta p^2 = .012$. These main effects were

not qualified by the gender alone F (1, 342) = .079, p = 0.779, ηp^2 = .000. Figure 1 shows that the interaction between gender and pupil condition was significant. As shown in figure 1 NA female pupils scored the highest on the FRTVMI whereas female pupils with RDs scored the lowest.

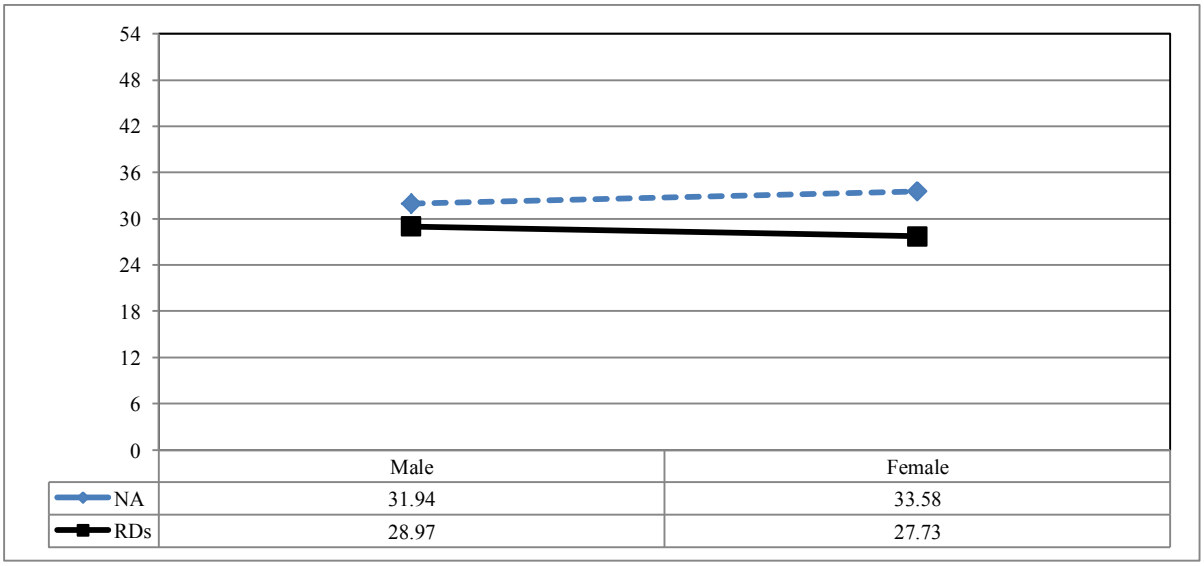

Figure 1. Effects of interactin between gender and condition on VMI

5. Discussion

The purpose of this study was to examine the differences in VMI between children with and without RDs in Oman. A related purpose was to examine whether gender and the interaction between gender and pupils condition (RDs vs. NA) have effects on VMI in children. The results of the study showed that there were significant differences in VMI between children with RDs and NA children. Children with RDs displayed a poor performance on the FRTVMI compared to NA children. The findings of the study revealed that gender did not have any effect on children's performance on the FRTVMI whereas the interaction between gender and pupil condition had an effect on children's performance on the FRTVMI.

The study findings can be discussed in relation to related literature and previous research studies. RDs have been studied from a variety of perspectives and there seems to be a general consensus in the literature that deficits in phonological awareness are a factor of RDs (Torgesen, Wagner, & Rashotte, 1994). There is less agreement, however, about other factors that may also play a role. For example, not only is Reading a linguistic process but it is also reliant upon visual input (i.e. deciphering written language). It is reasonable, then, to examine visual and other related processes to ascertain whether they play a role in RDs. For example, RDs have been associated with poor oculo-motor control (tracking, stereopsis; Eden, Stein, & Woods, 1995). Research on the VMI in children with RDs is fairly extensive (Boden & Brodeur, 1999).

With regard to the study questions the study found that NA pupils performed better than children with RDs on the FRTVMI and that gender alone did not have any effects on the children's performance on the FRTVMI in both groups whereas the interaction between gender and pupil condition showed an effect. A substantial body of research generally confirms higher visual-spatial and mathematical abilities in normally achieving males. However, the specific nature of these differences varies by age, specific measure, magnitude, and variability within the groups (Vogel, 1990; Boden & Brodeur, 1999). Re-analysis of earlier research showed that, although differences in visual-spatial ability were larger in males than in females, gender differences did not

account for more than 1% to 5% of the group variance (Vogel, 1990). A number of researchers (Vogel, 1990; Torgesen, Wagner, & Rashotte, 1994; Rosenblum, Larochette, Harrison, & Armstrong, 2010) argued that for children with LDs in general and RDs in particular research must be interpreted cautiously because LD samples were drawn mainly from the system-identified population and may reflect selection bias. They indicate that system-identified females with LD are lower in IQ, have more severe academic achievement deficits in some aspects of reading and math, and are somewhat better in visual-motor abilities, spelling, and written language mechanics than males with LD. A limited number of studies on research-identified samples indicate that findings from studies of school-identified LD samples must be interpreted cautiously because females with LD identified in the schools may not be representative of females with LD in general (Vogel, 1990; Boden & Brodeur, 1999; Rosenblum et al., 2010). This conclusion was partly supported by the study findings.

The study confirms previous research studies which showed that children with RDs have impairment in the visual motor abilities including VMI skills. This finding was reported in a number of studies which showed that children with RDs suffer from difficulties in perceiving and producing sensory motor information in rapid succession (Tallal, Miller, & Fitch, 1993; Ram-Tsur, Faust, & Zivotofsky, 2008). Similarly Kooistra, Crawford, Dewey, Cantell, & Kaplan (2005) found that the presence of RD was associated with more impairment in visual–motor skills as measured by the VMI. Based on previous research of the associations between children with LDs and motor performance, LDs can roughly be divided into reading disorders, mathematical disorders, and developmental speech and language disorders. Studies using the Movement Assessment Battery for Children (Vuijk, Hartman,Mombarg, Scherder & Visscher, 2011) showed a positive relationship between poor reading and poor motor performance, namely, children experiencing more reading difficulties also have a higher risk of motor problems (Cruddace & Riddell, 2006; McPhillips & Sheehy, 2004). Two studies (Barnhardt, Borsting, Deland, Pham, & Vu, 2005; Sortor & Kulp, 2003) found a similar positive association in children with poor mathematical achievements and their motor correlate, the Beery Developmental Test of Visual Motor Integration (VMI; Beery, 1997), a conclusion which may apply to children with RDs and which were partly confirmed by the current study.

Taken together, the study findings show a clear relationship between RDs and VMI skills, a relationship that becomes stronger when the interaction between gender and pupils condition is taken into account which often is the case (Fawcett & Nicolson, 1995; Dewey, Wilson, Crawford, & Kaplan, 2000).

6. Conclusion

The purpose of this study was to examine differences in VMI between children with and without reading disabilities. The study findings revealed that there were significant differences in both groups in VMI and that gender alone did not have any effect on children's performance on the FRTVMI except when it was in interaction with pupil condition. There are some limitations, however, of these findings. A number of methodological issues should be considered when interpreting the findings. First, children with RDs are often heterogeneous although they carry the same label. The selection of the participants was based on the assessment procedures in Oman which are dominated by the aptitude-achievement discrepancy approach which has been under criticism by a number of researchers (Vellutino, Scanlon, Small, & Fanuel, 2006). Therefore, future replication of this study in Oman is highly recommended. In future replications, however, the selection of children with RDs should be based on curriculum based measurements and domain specific tests such as those of phonological awareness and phonological processing. The reliability of the FRTVMI was based on internal consistency estimates. Future studies should consider test re-test reliability and other forms of validity in order to establish the psychometric properties of the test on Omani children. This requires also increasing the sample size and including children with other disability conditions particularly those with a history of developmental disabilities.

7. Implications

The current study includes a number of significant implications on the level of policy and practice. First, the Sultanate of Oman lacks the availability of trained professionals as well as instruments necessary for providing a comprehensive assessment of pupils with LDs in general and pupils with RDs in particular. This issue can be addressed through researchers' efforts to validate and test the psychometric properties of empirically valid instruments which were developed elsewhere by other researchers.. In addition, the diagnosis of LDs has been dominated in Oman and perhaps the Arab world by the discrepancy achievement approach. There has been less focus on cognitive processes and other variables that are associated with LDs. The current study is an effort to aid the assessment process of children with RDs in Oman. We empirically tested a newly developed instrument which was utilized by researchers in other contexts (Chinner eta al., 2011, Brown, Chinner, & Stagnitti, 2011, Brown, Chinner, & Stagnitti, 2010). In addition the study findings revealed that it is necessary to widen the assessment process of children with LDs in general and RDs in particular to include other important areas such as that of VMI. VMI seems to be a good indicator of a diagnosis of RDs. It is important therefore that schools reconsider the assessment procedures of children who are suspected of being at risk for academic difficulties as well as LDs. This may lead to better accommodate for these children in school and to help parent advocate for their children on the long run. Additionally, teachers will truly understand the cause of the child's academic difficulties, which may affect their teaching approach, support strategies, instructional techniques, and evaluation procedures. For these reasons, researchers are encouraged to test similar and other instruments that may improve the assessment procedures in schools in the Sultanate of Oman.

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